Fuller Brook Park Preservation Project – Phase 3
Final Design & Permitting
Wellesley, MA

Prepared for:

TOWN OF WELLESLEY
FULLER BROOK PARK COORDINATING COMMITTEE

Special Studies
Executive Summary

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A. Project Location

The Fuller Brook Park Preservation Project extends from Dover Road to Hunnewell Field following Fuller Brook and from Hunnewell Field to Washington Street at Maugus Avenue following Caroline Brook. As part of Phase 3 Final Design & Permitting, special studies were completed for the sections of the brooks within the park limit (see Project Locus Map).

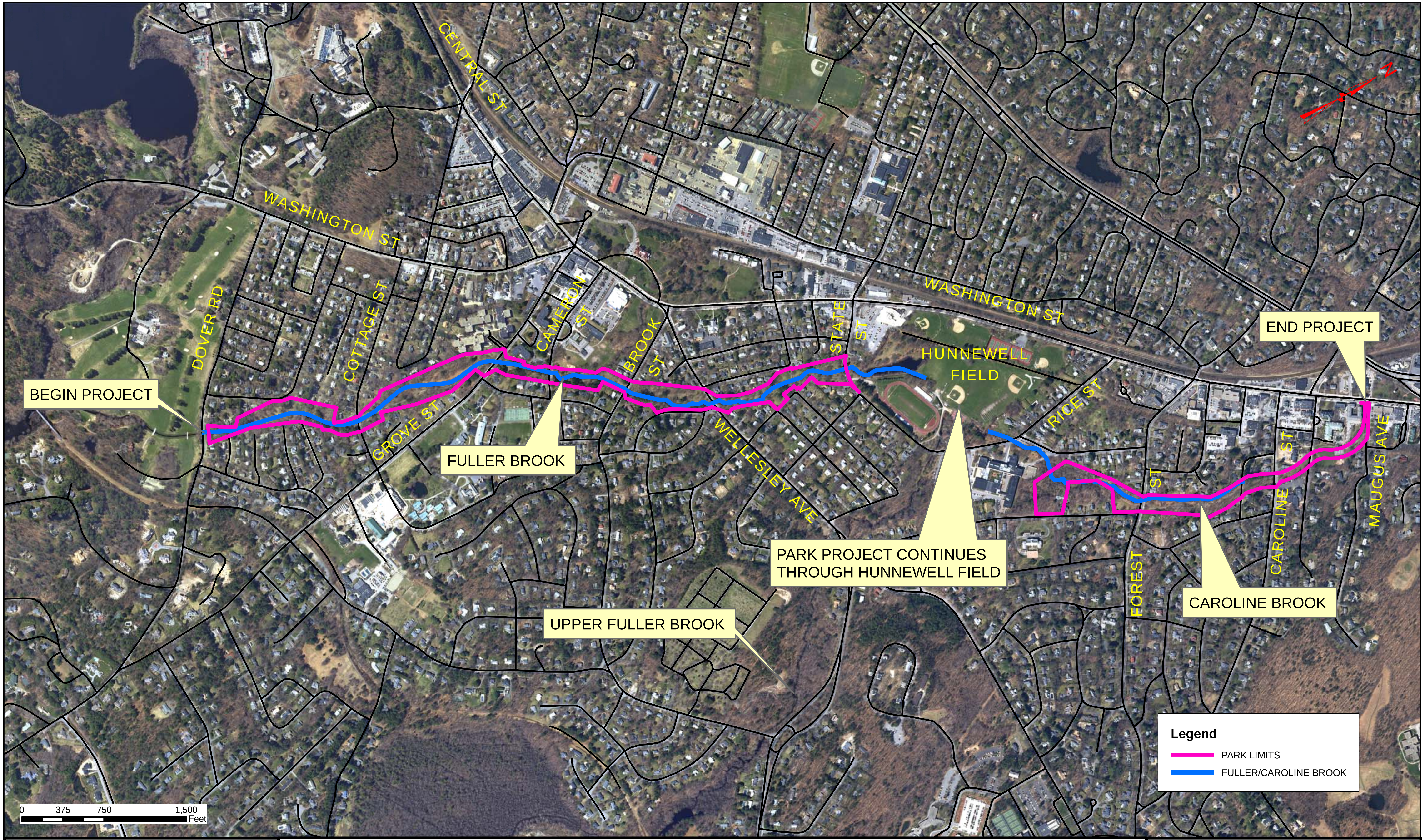
B. Purpose

The purpose of the special studies was to understand the characteristics and conditions of the brooks to help identify improvement opportunities in conjunction with the project. The special studies provide the fundamental data required for final design, and permitting. The four special studies include:

1. **Hydraulic Analysis (HA)** was completed to understand the characteristics of the brooks including capacity, flow rates, velocities, scour, and flooding for various storm events. It was developed to predict existing and proposed water surface elevations and flood depths, as well as to aid in the selection of the types of bank stabilization measures that will be used to address existing erosion problems.
2. **Sedimentation Investigation (SI)** was completed to identify possible sources of sediment in Caroline Brook and lower Fuller Brook and recommend actions to avoid or minimize future deposition problems, including structural and non-structural best management practices (BMPs) for stormwater runoff practices.
3. **Wetland and Seasonal Inundation Analysis (WSIA)** was completed to evaluate park areas that are reported to be frequently flooded (standing water at the surface) in order to select appropriate path alignment and materials and to create more natural wet meadow communities comprised of native hydrophytic species compatible with existing vegetation. Locations indicated on the preliminary plans as proposed wet meadow areas were further investigated for suitability, location, and elevation.
4. **Sediment Survey (SS) –** was completed to evaluate sediments in high sedimentation areas identified for dredging for potential contamination and appropriate reuse/recycle/disposal options.

C. General Observations

Caroline Brook has a 294-acre watershed, and Fuller Brook has a 2,244-acre watershed (of which, only 1,091 acres are in Wellesley). Over the years, development has occurred in these watersheds, changing the natural hydrology characteristics of the area (e.g., removing trees and other vegetation, adding impervious cover, etc.) and creating a pipe network that conveyed high volumes of stormwater runoff directly into the brooks with no treatment. Projects were also constructed in the brooks themselves that changed natural elevations, affected alignment, lined the streambed, and widened the channel in an attempt to increase buildable land and reduce flooding. These activities have affected the natural function of the brooks, which has led to erosion, sedimentation, and flooding issues typical of urban streams.



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FULLER BROOK PARK PRESERVATION PROJECT

WELLESLEY, MA

Project Locus Map

I. Summary of Observations from Hydraulic Analysis

Caroline Brook

Caroline Brook is 2,815± feet long from the headwall at Caroline Street to the culvert inlet at Hunnewell Field.

- It conveys runoff from a 294-acre watershed of predominately developed commercial and residential areas.
- The upper section, from Caroline Brook to Forest Street, is intermittent, drying up during extended periods without rain. It is also flat; this 900-foot section drops 0.7 feet, a grade of 0.08%, causing low flow velocities and sedimentation (See Sedimentation Investigation Report).
- The high elevation of the Forest Street culvert causes a very flat stream condition up-gradient and a steep condition just down gradient.
- Poor culvert alignment and elevated shear stresses[1] at Forest Street has contributed to severe bank erosion, exposing sewer pipe and manhole. (see further discussion of sheer stress in the following section on Stream Bank Erosion)
- Approximately 200 feet from Forest Street, the brook widens, becoming shallower and flatter in the swamp area south of Paine Street. An 80± feet long boardwalk/bridge section was installed to cross the brook/swamp area.
- The swamp, along with the 42-inch corrugated metal pipe (CMP) culvert crossing the High School driveway off Paine Street, acts as a detention system, regulating the flow through the lower portion of Caroline Brook.
- The high invert of the culvert at Hunnewell Field has caused an approximate 775 foot long reach just upstream of the culvert to be virtually flat, creating a sedimentation-prone condition.

Fuller Brook

Fuller Brook, within the park area, is 7,140± feet long from the Hunnewell Field culvert outlet to Dover Street.

- The confluence of the Caroline Brook and upper Fuller Brook, a 1,153-acre watershed, flows through the culvert below Hunnewell Field.

[1] Shear stress is a force acting on stream banks; it can be used to identify areas prone to scour and/or sediment deposition. Shear stress increases when stream depth and/or bed slope increases. High shear stresses generally yield conditions for increased scour, which transports sediment. Stream velocity and shear stress can also be related, but both should always be evaluated individually when making determinations about erosion potential. A good example of this in regards to the Fuller Brook HEC-RAS analysis can be observed in the results for Station 13+48. At this location, shear stress is very high relative to the rest of the project reaches. Conversely, velocity increases only moderately. The steep gradient (i.e., slope) change at this location produces the elevated shear stress results, and as a result, this area will likely be prone to significant erosion. If only velocity were considered in the analysis, erosion potential could be easily underestimated.

- The first 890± foot section, which includes the State Street Pond (aka Skating Pond) to the State Street culvert, is flat. The State Street Pond inlet and outlet culvert inverts are at the same elevation. The low gradient change across the pond decreases brook velocities and causes significant sediment deposition in the State Street Pond.
- The brook then flows through a narrow 4-foot wide stone block culvert/channel at the footbridge at the outlet to State Street Pond. Both the hydraulic model and the 2004 Stormwater Master Plan Update (SWMPU) indicate that this overtops for most storms of 2-year frequency and above.
- Just above State Street is the confluence with Abbott Brook, conveying flows from a 175-acre watershed.
- From State Street to Brook Street (2,160± feet), the Brook has a fairly consistent grade (0.07%) as it meanders through the park.
- The confluence of Cold Stream Brook, a 467-acre watershed, and Fuller Brook occurs between Brook Street and Cameron Street. Some bank erosion occurs throughout this section, most notably when the brook changes direction or shape. Just upstream of Cold Spring Brook, erosion of the bank has exposed sewer pipe. Cold Spring Brook appears to have a high concentration of iron-oxides, resulting in a rust-brown stream color.
- The Cameron Street culvert is the smallest at 4 feet by 8 feet, creating a flow constriction and causing some surcharging of the brook. Both the hydraulic model and the 2004 SWMPU indicate flooding in this area; water not does flow over the road for the 100-year storm event.
- From Brook Street to Dover Road (4,065± feet), the Brook straightens out and the grade increases to an average of 0.29%, increasing the flow velocity. This portion of the brook was engineered in the 1950s to provide a deeper, straighter channel to accommodate the flows. Over 4,500 linear feet of concrete liners and the Grove Street Flume were installed as an attempt to protect the banks and stream bed from erosion caused by high velocities. Due to development and increased impervious area, this reinforced channel has become undersized. Significant erosion behind the liners has occurred, resulting in over-widening of the channel.

Stream Capacity

The hydraulic model was evaluated to identify capacity issues within the project limits. It was found that the bank full flow[2] capacity for Caroline Brook and Fuller Brook is generally between the 1- and 2-year storm events with overbank flow remaining within the park for larger events (see Hydraulic Analysis Report Appendix C - Hydraulic Data).

The hydraulic model shows that Caroline Brook may have capacity issues; however, Town records do not indicate any known storm event flow or capacity problems. Difficulties in estimating runoff or storage capacity in the watershed may account for this discrepancy (see Hydrologic Analysis, Appendix A for more explanation). Upland storage capacity was modeled

[2] Bank full flow is the highest rate, at maximum elevation or stage water can flow within the defined banks of the stream. Any additional flow will flow in the floodway outside the banks.

using available GIS topographic data; data which may not accurately depict topography in the heavily wooded, wetland areas. The capacity discrepancy was most apparent in the Caroline Brook portion of the watershed.

Town reports do indicate that, under some flow conditions, flooding is a concern between State Street and Cameron Street. The issues were specifically observed when a significant rainfall event occurred during late winter with frozen ground and a heavy snow cover. This type of event cannot easily be predicted in a hydraulic model due to the unusual circumstances. This observed event should be considered an anomaly for the purpose of this analysis.

Culvert/Bridge Capacity

Caroline Brook has six culverts of various sizes and materials. The 60-inch dia. reinforced concrete pipe (RCP) culverts crossing roadways at Forest Street and Rice Street have sufficient capacity to convey flow for the 100-year storm events. Three smaller (42”-48”) culverts crossing driveways and footpaths are overtopped during larger storm events. The hydraulic model indicates that the arch culvert under the Hunnewell Field also does not have capacity to accommodate the larger storm events.

Within the project limits, Fuller Brook has seven culverts and four footbridges. The first of these is a narrow 4-foot wide stone block culvert/channel at the footbridge at the outlet to State Street Pond. Both the hydraulic model and 2004 SWMPU indicate that this overtops for most storms of 10-year frequency and above.

The State Street culvert is a concrete arch with mortared stone headwalls. Wellesley Avenue and Cameron Street culverts are concrete box culverts with mortared stone headwalls and arch openings. The Brook Street culvert is a pair of 72-inch RCPs with stone block headwall and wing walls. The Cameron Street culvert is the smallest at 4 feet by 8 feet causing some surcharging of the brook. Both the hydraulic model and reports to the Town indicate flooding in this area; water however does not flow over the road for the 100-year storm event. The three lower reach culverts, Dover Rd., Cottage St. & Grove St. were constructed along with stream improvements in the 1950s. They are oversized concrete box culverts with wing walls of sufficient size to accommodate the 100-year storm event. They have utilities passing through them, but they are high enough not to be affected by flows in the Brook (Photo 1).

All culverts including headwalls and wingwalls are generally in good condition, except the 48-inch diameter RCP culvert for the footpath off Smith Street, which is deteriorated and steel reinforcing is exposed (Photo 2). It should be noted that the bottom of the culverts on the lower portion of Caroline Brook were not observed due to being submerged and partially filled with sediment.

Photo 1: Cottage St. culvert with utilities

Photo 2: Footpath culvert off Smith Street

Stream Bank Erosion

Photo 3: Steep, poorly vegetated slopes along upper Caroline Brook

Photo 4: Erosion exposes sewer infrastructure down gradient of Forest Street

Stream bank erosion for upper Caroline Brook from Caroline Street to Forest Street is due primarily to the lack of vegetation on the banks (Photo 3) and lack of natural sinuosity[3] in the brook; the brook is severely channelized across this reach. Abutting owners have installed railroad ties and stone as an attempt to prevent additional property loss.

The most severe signs of stream bank erosion are observed downstream of the Forest Street culvert. Poor culvert alignment, steep gradients, and elevated shear stresses have contributed to the exposure of the adjacent sewer infrastructure. The risk of sewer line failure at this location is

[3] Sinuosity relates to the bending or curving shape of a river or stream. Streams attempt to maintain a balance between slope, sediment loads, and energy by naturally adjusting their sinuosity. When bank erosion is observed in a straightened segment of stream, it suggests that the system is attempting to arrive at the natural balance by forming a more sinuous condition. In the case of Caroline Brook at the straightened segments, abutters have attempted to stop bank erosion and property loss through the use of railroad ties and stone for stabilization.

high given the current conditions (Photo 4). A second section of abandoned sewer pipe is also exposed just up-gradient of the confluence of Cold Spring Brook.

Due to attempts over the years to straighten, lower, and generally increase the capacity of Fuller Brook, most of the natural banks and stream bottom have been impacted. The disturbance and straightening of the brook, in addition to increased development within the watershed, causes velocities and flows to increase which in turn, contributes to erosion (Photo 5) and changes in brook shape. This can be seen throughout the section of Fuller Brook to varying degrees, most significantly around locations of drainage outfalls and concrete liners (Photo 6).

Photo 5: High shear stress cause erosion of stream bank

Photo 6: Erosion outside concrete liners

Drainage Outfalls

The brooks are a significant part of the overall stormwater management system for the Town of Wellesley. Outlets from street drainage systems are routed directly to the brooks. The majority of these drainage systems were constructed before the effects of stormwater discharges were fully understood and before treatment was deemed necessary or required. Many of the outfalls are failing due to erosion of the banks (Photo 7) or from excessive aggradation (See Hydraulic Analysis Report Summary of Drainage Outfalls in Appendix E). Two outfalls from Marvin Road drainage systems were observed below the mud line indicating that the elevation of the bottom of the brook has raised since these systems were installed.

It is likely that much of the existing drainage infrastructure is undersized for the current level of development. Some potential drainage improvement recommendations to address stormwater treatment are described in more detail in the Sedimentation Investigation Report. Details for improvements to the individual outfalls (inventoried in the Hydraulic Analysis Report Appendix E) within the project limits will be included as part of the design improvements.

Photo 7: Erosion undermines drainage outfall

Photo 8: Headwall undermined & trees disrupt outfalls

II. Summary of Observations from Sedimentation Investigation

The following four areas were identified as high sedimentation area sections:

1. Caroline Brook from Caroline Street (sta.130+78) to Forest Street (sta. 121+80) - 900± ft. ~ 11,460± sq. ft., approximately 12 inches deep = 424± cu. yds.
2. Caroline Brook from just up-gradient of a driveway off Paine Street (sta. 110+50) to the culvert at Wellesley High School (sta. 102+63) - 790± feet ~ 4,925± sq. ft., approximately 12 inches deep = 182± cu. yds.)
3. Fuller Brook from culvert at the Wellesley High School (sta. 81+97) to Abbott Brook (sta. 74+74) including State Street Pond - 723± feet ~ 55,135± sq. ft., approximately 18 inches deep = 3063± cu. yds.
4. Fuller Brook at locations of various drainage outfalls - say 25 cu. yds.

Sections 1-3 above are areas where the stream has little to no profile grade resulting in low velocity flow (see Hydraulic Analysis Report for additional information). Low velocities cause larger suspended particles in the flow to settle out, resulting in deposition of sediments in the stream, culverts, and wetland resources. Preliminary total dredge volume is estimated at 4,000± cu. yds.

Sources of Sedimentation and Debris

1. <u>Stream Bank Erosion:</u> Caroline Brook through Section 1 has a high canopy of tree cover but little in terms of vegetated ground cover. Banks are steep (Photo 9) and susceptible to erosion from stormwater runoff from adjacent land as well as from stream flow from significant storm events. Erosion material from steep banks and areas of high shear stress identified in the Hydraulic Analysis Report deposit eroded material to down gradient sites where velocities and stresses are lower. In general, channelization of the brooks for flood control and upland development has caused the brooks to become “flashy” stream systems. This means that stream flows rise and fall quicker and to higher elevations during and after storm events than in a natural system where runoff is infiltrated and

attenuated within an undeveloped stream corridor and floodplain. The existing storm drain network carries runoff quickly to the brooks starting from rooftop to pavement, catchbasin to pipe outfall.

2. Exposed Soil: Caroline Street is a gravel road (approximately 500 feet in length) where it crosses the park (Photo 10). Stormwater runoff from the road is collected in catch basins, which discharge directly into the headwaters of Caroline Brook via a drain pipe and headwall. Exposed soils during construction periods can also be a problem if not maintained with proper erosion and sedimentation control (ESC) measures. The ongoing construction at the Wellesley High School, as well as any other site in the watershed, should be carefully monitored, and ESC measures should be installed and maintained as necessary.

Photo 9: Erosion of steep stream bank

Photo 10: Gravel & catchbasin in Caroline St

3. Stormwater Runoff: As mentioned above and like many communities with older municipal drainage systems, stormwater runoff is directed to surface streams with little to no prior treatment. The brooks have essentially been used as part of the stormwater management system for a major portion of the Town streets. They have been modified several times over the last century to primarily provide better flood control for the center of town. Catch basins and pipe systems collect and discharge stormwater runoff from streets, yards, and parking lots to the brooks. Not only does this increase peak flows to the stream as discussed above, but it also has little to no capability to provide effective capture and removal of sediments and other stormwater pollutants (Photo 11).

4. Landscape Materials: Often, parks, wooded areas, and wetlands are a place where residential landscape debris (leaves, grass clippings, mulch and excess soil) are often disposed. Although not observed during the site visit conducted for this investigation, it is likely that some landscape debris is being improperly disposed in the watershed and is entering the brooks.

Photo 11: Wellesley Square drainage systems outlet at Caroline Street Headwall

Photo 12: Sediment deposits in Caroline Brook

Issues with Sedimentation

Sands and other debris are deposited where stream velocities are slow enough for them to settle out. This can be clearly seen at the headwall at Caroline Street. Once the sediment levels in the brook exceed the available storage capacity, sediment is then transported to the next settlement area, and the process repeats itself until equilibrium is established. Excessive sedimentation has reduced the brook's capacity to convey runoff and ability to attenuate stormwater during periods of high runoff, often resulting in property damage and/or dangerous flooding conditions. In addition, Fuller Brook is listed by Massachusetts Department of Environmental Protection (MADEP) as an impaired waterway for pollutants; organic enrichment/low dissolved oxygen and siltation, and has a total maximum daily load (TMDL) for pathogens.

Fuller Brook is tributary to the Charles River, which MADEP lists as impaired for bio-assessment, noxious aquatic plants, nutrients (specifically, phosphorus), PCBs, and pesticides. Other pollutants often attach themselves to sediment particles; therefore, capturing and removing solids will significantly reduce the pollutant load to the brook. In addition, as the areas identified above accumulate sediment, they become less effective at capturing particles/pollutants; thus, removing accumulated sediment will help to restore some natural treatment capability.

The Town is required to address sediment and other stormwater pollutants to comply with the existing National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4s). The Town currently performs street sweeping, catch basin cleaning, oil/water separator units cleaning, and has conducted outfall inspections and responded to stormwater hotline issues to meet the permit requirements, as well as several public outreach and involvement activities. Sand is no longer frequently used on the streets during the winter, and a rain garden demonstration project has recently been completed.

However, there is a new permit currently in draft form – the Draft NPDES General Permit for Stormwater Discharges from small MS4s in Massachusetts North Coastal Watersheds. This pending permit includes much more stringent requirements for stormwater management in the Town, including specific requirements for areas subject to TMDLs. For example, when this permit is final, the Town of Wellesley will be required to reduce phosphorus loads by 59% and pathogens by 94.5%. As a result, the Town will need to both reduce these pollutant loads from Town-owned lands (e.g., public streets and parking lots) and from contributing private lands as well. Since the park includes a great deal of open space adjacent to many untreated stormwater discharges, effort should be made to not only reduce sediment impact to the brooks but also consider opportunities to address these anticipated permit requirements on Town-owned land and in the contributing drainage area.

III. Summary of Observations from the Wetland and Seasonal Inundation Analysis

Specific field observations were conducted after several days of rain on two occasions. Areas of standing water of various sizes were observed through the park; these areas within the park were identified as wet areas and/or locations where wet meadows could be created as being areas subject to inundation. Inundation in these areas is caused primarily from stormwater runoff flow having difficulty flowing to the brook and not from brook flow. The following is a summary of observations of the four sections identified previously in Phase II.

1. Cold Spring Brook to Brook Street

This is predominately an open grass area sloping 5-6% toward Fuller Brook from elevation 128 to 122 feet, while the southern edge slopes to Cold Spring Brook. The small 0.5± acre contributing drainage area primarily only includes the park area and portions of the abutting condominium property to the west. Some areas of standing water were observed (Photo 14) in the paved path after rain events, but no standing water was observed in the remaining park area. Data from the hydraulic analysis for this segment indicate flooding is not an issue until the 10 year frequency storm event.

Photo 13: Looking south toward Cold Spring Brook

Photo 14: Looking north toward Wellesley Ave.

Preliminary plans for this project include realigning the path and creating two wet meadow areas, one on either side of the path (See Wetland & Seasonal Inundation Analysis Fuller Brook Plan).

2. Brook Street to Wellesley Avenue

This area is a mixture of woodland and lawn area with large trees. The path along the west side of the brook creates a partial barrier, preventing some overland flow from reaching the brook. Two pipe culverts, a 12-inch RCP) and an 8-inch clay pipe, were installed to direct accumulated water in this area to the brook. Although the Town mows the lawn area, portions are delineated as bordering vegetated wetland (BVW), and were included in the approved Order of Resource Area Delineations (ORAD) for this project. Ponded water was observed in the BVW lawn area as much as 8 inches deep after rainfall events (Photo 15). Hydrologic data indicates that the brook overtops the path during the 10-year storm event. Data from the hydraulic analysis for this segment indicate flooding is not an issue until the 10 year frequency storm event.

Preliminary plans for this project include realigning the path to the west and creating a wet meadow area along the bank of the brook (See Wetland & Seasonal Inundation Analysis Fuller Brook Plan).

Photo 15: Looking south between Wellesley Ave & Brook St

Photo 16: Again looking south between Wellesley Ave & Brook St

3. Wellesley Avenue to Morton Street Footbridge

This section on the west side of the brook is a low-lying mixture of mowed lawn with a high canopy created by large trees with, and vegetated areas primarily adjacent to the brook. The land varies in slope from 1-6% toward Fuller Brook, from elevation 126 to 123 feet. The 1.5± acre contributing drainage area includes the residential lots on the east side of Aberdeen Road. Some areas of standing water and saturated ground behind house numbers 5, 13 & 15 Aberdeen Road were observed after rain events. Data from the hydraulic analysis for this segment indicate flooding is not an issue until the 10 year frequency storm event.

Note that the path is located on the east side of the brook (i.e., not in the area where wet meadow is being proposed). Preliminary plans included creating two wet meadow areas along the west bank of the brook (See Wetland & Seasonal Inundation Analysis Fuller Brook Plan).

Photo 17: Looking south toward Wellesley Ave

Photo 18: Looking north toward Morton St Footbridge

4. Paine Street to Forest Street

The park path traverses a low-lying forested swamp area east of Paine Street. Wetland resources are delineated on both sides of the existing wood chip path. A wooden boardwalk/bridge was installed for pedestrians to cross the brook. There are also three 8-inch clay pipes installed to allow water from wetlands on the north side of the path to flow beneath the path to the brook. During a site visit in May 2012, it was observed that a new layer of wood chips had been installed to prevent pedestrians from walking on saturated soil.

The path in this area is only ~12 inches higher in elevation than the adjacent wetlands areas. The three 8-inch clay pipe cross culverts are either partially or completely buried/blocked, preventing flow from the western wetland area from reaching the brook. During most rainfall events stormwater flow saturates and often overtops portions of the path at the culverts (Photo 19) and both ends of the boardwalk (Photo 20).

Photo 19: Stained wood chips where flow overtops path at clogged culverts

Photo 20: Saturated path at end of existing boardwalk

IV. Summary of Observations from Sediment Survey

A sediment sampling program was completed in three areas located along Caroline Brook and State Street Pond identified as part the sedimentation investigation. Samples were compared standards established by the MassDEP, as described below, in order to evaluate the following:

1. Can the sediments able be reused at locations within Wellesley?

In order to evaluate this, the data was compared to reportable concentration standards (RC-S1). These standards are developed by the MassDEP and located in regulations 310 CMR 40. RC-S1 standards are utilized for determining if a MassDEP notification condition obligation exists due to an elevated concentration in soil. It should be noted that these standards are for soil and do not apply to sediment, but are being used for comparison purposes to evaluate sediment disposal and potential re-use alternatives.

2. Or, are the sediments that need to be disposed of off-site able to be disposed of at a Massachusetts lined landfill?

Representative samples collected from these areas were analyzed for parameters established in Massachusetts Department of Environmental Protection (MassDEP) policy COMM 97-001. The COMM 97-001 policy establishes analytical testing requirements and standards which are used to evaluate if contaminated soil is able to be disposed of or reused at Massachusetts landfills. BETA compared the data to Table 1 in the COMM 97 policy.

Samples were collected as both composite samples and grab samples. Composite samples are collected in multiple locations in a specific area and combined and treated as a single sample to represent that area, versus a grab sample that is collected from a specific location and analyzed.

Grab samples were collected in the vicinity of outfalls as well as the samples analyzed for volatile organic compound (VOC) analysis in order to evaluate if elevated concentrations were present in sediments in vicinity of the outfalls in comparison with the surrounding sediments.

A highly organic sediment was found in the State Street Pond at depths ranging from approximately 1-3 feet. This sediment extended above the water line in some areas of the Pond. Beneath the organic-peat is a fine, grey, silty-sand. Fuller Brook was observed to have a smaller thickness of the sediment material mixed with a fine to coarse sand from 0-8”, followed by a grey silt.

Photo 21: Organic Material State St Pond

Photo 22: Sediment observed at surface of State St. Pond

A sediment material similar to the State Street Pond was observed in lower Caroline Brook to depths of approximately 3 inches, followed by a fine to coarse sand and small gravel. Organic fibers, including mulch/tree bark, were noted in some samples.

Trace organics and peat was observed in Upper Caroline Brook from 0-6". Fine to coarse sand and gravel was noted to depths of 18".

Photo 23: Between Rice St & Paine St.

Photo 24: At inlet to Forest Street culvert

Laboratory Analytical Results

Results were compared to RC S-1 standards to evaluate the potential for on-site reuse relative to the anti-degradation policy in the Massachusetts Contingency Plan (MCP). Samples were also compared to limits associated with COMM 97 parameters for potential off-site re-use at a Massachusetts lined landfill. A summary of the results is below.

Total Petroleum Hydrocarbons (TPH): TPH concentrations were detected in each of the thirteen (13) samples. No samples exceeded the RC S-1 standard or COMM 97 limit.

Volatile Organic Compounds (VOC's): VOC samples were collected as grab samples. VOC's were not detected in any sample above the applicable laboratory detection limit.

Polychlorinated Biphenyls (PCB's): PCB's were not detected in any sediment sample above the applicable laboratory detection limit. During the PCB analysis, the laboratory picked up the presence of Chlordane, a noted pesticide. As previously mentioned, Fuller Brook is tributary to the Charles River which EPA lists as impaired for pesticides. Estimated results for Chlordane was provided by the laboratory and each of the estimated concentrations were below its RC S-1 standards.

Semivolatile Organic Compounds (SVOC's): SVOC's were detected in all thirteen (13) samples. Of these samples, five (5) exceeded the RC S-1 standard for one or more constituent. Two of the RC S-1 exceedances were from samples collected in upper Caroline Brook, two were from samples collected in lower Caroline Brook, and one composite sample with SVOC exceedances was located at the State Street Pond. No samples exceeded the COMM 97 limit.

Total Metals: Chromium was detected in 3 samples above RC S-1 standards. Arsenic was detected in one sample above the RC S-1 standard. No metal constituents exceeded COMM 97 limits. In accordance with COMM 97, if any total heavy metal concentration exceeds 20 times their respective leachate value for characteristically hazard waste, a toxicity characteristic leaching procedure (TCLP) test needs to be conducted on those samples in addition to meeting the metal concentration. Three (3) samples for lead exceeded their respective leachate value and require a TCLP test. BETA has submitted samples SD-1, SD-G-2, and composite sample SD-8 for TLCP lead analysis. The TCLP concentrations were <0.1 mg/l and < 0.2 mg/l, respectively for these samples.

<u>Special Studies: Conclusions and Recommendations</u>

As a result of the special studies completed to date, the following are recommendations for consideration as part of the Fuller Brook Park Preservation Project or future improvement projects within the watershed. These recommendations were ranked to prioritize overall project improvements from highest to lowest and shown graphically on the attached plans and outlined below. For ease of review the respective studies in which the recommendations were developed are referenced as follows:

HA = Hydraulic Analysis,
SI = Sedimentation Investigation,
WSIA = Wetland and Seasonal Inundation Analysis
SSS = Sediment and Soil Survey

1. <u>Highest Priority</u> - Recommended project improvements – In scope of work (present in no particular order).

    1.1. Dredge Caroline Brook stream bed from Caroline Street to Forest Street to remove accumulated sediments, including two tributary swales. (HA & SI)

    1.2. Dredge Caroline Brook stream bed from High School driveway off Paine Street to Hunnewell Field culvert to remove accumulated sediments. (HA & SI)

    1.3. Dredge stream bed and State Street Pond from the Hunnewell Field culvert to the confluence with Abbott Brook to remove accumulated sediments. (HA & SI)

    1.4. Remove remnants of existing railroad tie walls between Caroline Brook to Forest Street and vegetate/stabilize banks as necessary. (HA)

    1.5. Reinstall/upgrade street drainage pipe outletting at Forest Street and install outlet sediment trap/energy dissipater. (HA & SI)

    1.6. Provide improvements to drainage outfalls to repair and protect against erosion. Evaluate opportunities to re-use concrete liners within the project, possibly for energy dissipation at drainage outfalls and/or to create riffle-pool sequences within the stream channel. (HA)

    1.7. General maintenance/repairs to repoint mortar stone and block walls for culvert/bridges. (HA)

    1.8. Install stream bank stabilization measures for the eroding stream sections described below and shown on the Special Studies Recommendations Plans. Both hard and soft stabilization measures are recommended based on the results of the hydraulic analysis. Hard stabilization techniques include concrete, riprap, gabions or other engineered hard structures. Soft stabilization techniques include vegetation, coir logs, coir blankets, or other natural practices. (HA)

        See Recommendations Plans for proposed areas of hard stabilization, combination of soft and hard stabilization, and soft stabilization.

    1.9. Cold Spring Brook to Brook St. area: Realign the path as proposed and construct an upland meadow community in the locations previously proposed as wet meadows. (WSIA)

1.10. Brook St. to Wellesley Ave. area: Realign the path as shown on the Special Studies Recommendations Plan (Sheets 7 & 8), incorporating an elevated walk section where wetland crossing occurs. The existing 12-inch drainage pipe would be removed since the walk would span the wetland areas, maintaining hydrologic connectivity between the wetlands and the brook. Construct a wet meadow habitat community with the bottom at elevation 123.2 to 123.7± feet by expanding along the existing wetland boundary and planting additional native herbaceous wetland species. Create a diversified habitat within the proposed wet meadow area by excavating to approximately elevation 122± feet. Areas north of the pathway should be planted with woody vegetation to enhance and expand the existing wooded portions of the wetland without the need for excavation. (WSIA)

1.11. Wellesley Ave. to Morton St. Footbridge area: Create one wet meadow in this area, shaping it to minimize impacts to the root systems of the large existing trees. This wet meadow will have the added benefit of providing additional floodplain storage in this area. (WSIA)

1.12. Paine St. Swamp area: Remove saturated path section and fill material to allow unrestricted flow within the wetland; restore wetland and extend new elevated walk to the north 35± feet. Remove saturated path section and fill material to allow unrestricted flow; restore wetland and extend new elevated walk to the south a minimum of 40± feet. (WSIA)

1.13. An estimated 50% of the sediment material from the State Street Pond will be able to be relocated in town, provided that it meets the anti-degradation provisions of the MCP, 310 CMR 40.032(3). Specifically, it is not to be re-used at a location which would trigger a reporting condition or where the concentrations of existing contaminants at the proposed location are significantly lower than the material being relocated. (SS)

1.14. Dispose other sediments with SVOCs that exceed RC S-1 standards at a lined landfill. (SS)

2. <u>High Priority</u> – Recommended project improvements – Added to scope of work

2.1. Install stormwater retrofits in available open space in the section of park upstream of Caroline Street. While "day-lighting" this section is not currently feasible, stormwater treatment can be provide for over 20% of the watershed currently flowing untreated to the headwaters of Caroline Brook. A constructed wetland and two bioretention areas should be installed for treating runoff from small stall events from a portion of Caroline St., Abbott Rd., and Seaward Rd. These retrofits are vegetated and can be designed to complement the park and path layout, while reducing sediment and other pollutant loading to the brook. (SI)

2.2. Relocate/stabilize the stream bank east of Forest Street to protect the exposed sewer main and reduce erosion. (HA)

2.3. Remove abandoned sewer that has been exposed in and west of Cold Spring Brook. (HA)

2.4. Install new, higher outlets for Marvin Road drainage system. (HA)

2.5. Paine St. Swamp area: Address additional saturated path sections not previously identified in the preliminary plans by removing damaged/blocked culverts and fill material; restoring the disturbed wetland; and installing two 20± feet boardwalk/bridge sections at low areas to re-connect wetland areas and allow unrestricted flow. (HA & WSIA)

3. Medium Priority – Recommended project improvements - Not in scope of work

3.1. Repair/replace or remove footpath culvert off Smith Street to Hunnewell Field. This culvert is in fair to poor condition and may not be necessary with new path system. (HA)

3.2. Divert runoff from small storm events (first flush) from the storm drain that outfalls on the eastern bank just south of Forest Street into a treatment BMP in the large, adjacent open space within the park. This outfall was specifically identified as a problem site, discharging runoff from a large drainage area of 62 acres, with 24% impervious. (SI)

3.3. Retrofit/install BMPs to treat runoff from street system, reducing the need for future dredging of the entire brook and limiting the overall environmental impact of the process. These BMPs should be designed to not only address sediment, but also phosphorus and bacteria. These are pollutants of concern in Wellesley and will need to be addressed when the pending National Pollutant Discharge Elimination System (NPDES) permit requirements go into effect. A full retrofit inventory/watershed assessment could help identify all the best opportunities. Effective BMPs could include: (SI)

- Rain gardens, bioretention systems, water quality swales in strategic locations; for instance, at end of streets abutting park.
- Remove catchbasins that connect directly to main drainage pipes and roadway culverts; this is referred to as "on-line" catchbasins. Provide off-line treatment practices to remove pollutants before discharge to the brooks.
- Removing excess impervious cover where possible.

4. Low Priority – Recommended project improvements - Not in scope of work

4.1. Any future upgrades to the Hunnewell Field culvert should include lowering inlet to improve the hydraulic function of the lower Caroline Brook section. (HA & SI)

4.2. Any future upgrades to the Forest Street culvert should also include improving culvert alignment and decreasing the culvert slope as necessary. These improvements will help to reduce erosion and risk of sewer failure. (HA)

4.3. Take advantage of opportunities to make improvements to the brooks as part of other activities. For example, as streets are re-paved or otherwise improved, investigate opportunities to reduce impervious cover (e.g., reduce street widths) and retrofit the existing drainage systems by adding treatment BMPs. Work with adjacent residential and commercial property owners to make similar improvements on their properties. (SI)

4.4. Continued maintenance of roadways (street sweeping) and existing stormwater management systems. Avoid using sand on roads during the winter unless absolutely necessary. (SI)

4.5. Adopt erosion and sedimentation control (ESC) regulations and carefully review and monitor ESC plans and/or stormwater pollution prevention plans (SWPPP) for all permitted construction sites. (SI)

4.6. Continue providing on-going public education on the importance of stormwater management and how to properly dispose of landscape/yard wastes. For example, if every resident managed their rooftop runoff with dry wells, rain barrels, or rain gardens, the quantity of runoff (which can cause erosion) would be greatly reduced and the quality (sediment and other pollutant loads) would be improved. This is particularly important since the major land use in the Caroline Brook watershed is residential. (SI)